Advantage warfighter: ERDC research gives U.S. forces the edge
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New enemies, new weapons, and war waged in new environments are challenges our military forces will face on future battlefields. The U.S. military must revolutionize into a smaller, lighter, and more lethal force in order to combat future challenges. But the future is now.

U.S. military forces will face new challenges on future battlefields. To meet these challenges, the Army is transforming to a smaller, lighter and more lethal force. (photo courtesy U.S. Army)

The U.S. Army Engineer Research and Development Center (ERDC) is leading the charge toward Army transformation by developing technologies to assist soldiers as they ***maneuver, deploy, sustain, survive*** and ***train*** so that we will have every advantage possible to dominate the battlefield.

Maneuver

In any military operation, commanders must be able to move the total force – troops, equipment, supplies – from theater entry points to movement on the battlefield. Theaters of operation might have limited infrastructure, and/or existing transportation networks may be damaged. A damaged bridge could be a bottleneck for logistics flow to our units – from divisions to small fighting forces.

The ERDC is developing techniques to predict rapid performance and assessment of existing lines of communication; investigating methods and materials to rapidly construct and repair roads, bridges, and drainage facilities; and evaluating capabilities to improve engineering response during military operations.

Another aspect of maneuver support is to predict, detect and avoid anti-tank and anti-personnel mines and minefield locations. The ERDC is collaborating with the U.S. Army Night Vision and Electronic Sensors Directorate to improve our ability to detect mines and minefields; to discriminate sensor response anomalies between landmines and those generated by the environment or geology to reduce false alarms; and to provide pre-mission prediction of sensor performance in specific geological and environmental settings to aid warfighters in selecting and deploying sensors.

The initiative will model and measure the mechanical, thermal, seismic/acoustic, electromagnetic, and chemical properties of surface and near-surface terrain. This technology has also been applied to a wide range of problems including vehicle mobility, unexploded ordnance detection, site characterization, surface energy, target tracking, and target background signatures.

The effects of battlespace environments - terrain and weather – can also have a significant impact on military forces and their ability to maneuver. The ERDC is conducting Battlespace Terrain Reasoning and Awareness (BTRA) research to provide decision support tools to commanders so they can understand and use terrain and weather to their advantage.

BTRA tools use measured and forecasted weather to predict weapon sensor performance and weather influences upon on- and off-road mobility; to analyze and predict maneuver options by looking at cover, concealment, defensible positions, etc.; and to perform automated terrain analysis based on enemy doctrine, equipment constraints, operational posture, and terrain effects.

In the future, our forces will depend heavily on unattended ground sensors to monitor enemy forces and non-combatants in an area of operation. Seismic and acoustic sensors show great promise but are susceptible to environmental conditions. ERDC researchers developed a high fidelity, physics based seismic simulation test bed, producing a seismic proving ground that gives results indistinguishable from field data. This simulation tool provides new methods for calibrating sensors to specific geologic conditions at the sensor's location.

The C-17 aircraft is one of the workhorses for transporting troops and materials (photo courtesy of ERDC).

Deploy

Under Army transformation, commanders must be able to deploy a brigade within 96 hours, a division within 120 hours, and five divisions within 30 days, to any location in the world. The first force elements will move by strategic airlift. In many areas of the world, adequate airfield facilities are non-existent or have severely deteriorated.

The C-17 aircraft is one of the workhorses for transporting troops and materials. While it is designed to operate almost anywhere (unsurfaced, unimproved pavements, and surfaced airfields), unimproved airfields cannot support numerous takeoffs and landings without significant maintenance delays. Military engineer units currently do not have the tools or capabilities to rapidly upgrade or construct airfields.

The ERDC Joint Rapid Airfield Construction (JRAC) program is addressing this critical problem. JRAC will provide an integrated site selection, design, construction and maintenance package to military units. The JRAC program is divided into three research areas: performance-based site selection; rapid stabilization; and enhanced construction productivity.

Remote sensing devices, satellite imagery, geospatial data, and computer modeling are key technologies used in site selection for airfields. (photo courtesy of ERDC)

The site selection process uses existing technologies that allow remote analysis of proposed airfield sites to reduce personnel requirements for construction. Remote sensing devices, satellite imagery, geospatial data, and computer modeling will be key technologies in the site selection process.

To stabilize an unsurfaced or partially prepared airfield, an engineer unit usually adds traditional stabilizer materials (portland cement or lime) to the soil that require extended curing times (up to four weeks). ERDC has researched mechanical stabilizers like synthetic fibers, foamed asphalt, chemical stabilizers (polymers and enzymes), and new lightweight matting systems to expand airfield aprons and other low-speed areas. These methods will provide the bulk of timesavings in the contingency airfields arena. To reduce logistical burdens, soil stabilizers must be lightweight and should require minimal mixing and application equipment, but have widespread usage capabilities (many soil types, conditions and environments).

ERDC is also researching expedient airfield construction methods to save valuable time during military operations. It can take several weeks, or even months, to construct a semi-prepared airfield for military transports. ERDC engineers are looking at new technologies in earthmoving equipment; pulverizers to mix soil stabilizers more efficiently and at greater depths; advanced compaction technologies to allow compaction of thicker lifts; and quality control tools.

These technologies will provide quicker construction capabilities for contingency airfields to ensure our forces and their equipment get there quickly and in sufficient numbers to achieve the mission.

Sustain

The ERDC Rapid Port Enhancement program focuses on development of lightweight causeways to provide a rapidly emplaced link between a transport vessel and land (photo courtesy of ERDC).

The Army's ability to use ground transportation networks and contingency airfields will play a vital role in the success of any military operation. Recent war games have also demonstrated the value of sealift to the Army's force projection requirements. For some operations, it will be important to rapidly repair, construct or upgrade existing port facilities. This will allow the Army's future Theater Support Vessel (TSV) to unload cargo effectively in underdeveloped or damaged ports.

The Army is counting on the TSV, a high-speed, shallow draft vessel, to provide the means to access all coastal regions of the world. The TSV will be able to deliver personnel and equipment together in a "ready to fight" mode.

The ERDC Rapid Port Enhancement program is focusing on the development of lightweight causeways that can be carried on a TSV to provide a rapidly emplaced link between the vessel and land. Initial studies indicate that the system can increase throughput rates 200 - 400 percent. Other components of the program include modeling tools for port assessment and selection, enhanced breakwater construction and repair, rapid pier upgrades, and expedient channel deepening.

Whether they reach land by air or by sea, vehicles must provide optimal performance moving to and through the battlefield. ERDC is also developing new modeling and simulation technologies to assess vehicle performance. The Virtual Evaluation Site (VES) will evaluate the stability, handling, ride, mobility, and durability of conceptual ground vehicles over all terrains under all weather conditions. VES will allow evaluation and improved development of future Army systems over high-resolution digital representations of common proving grounds, typical operating environments, and purely virtual worlds.

ERDC is testing heavy gauge wire panels, lined with lightweight geotextile fabric, and connected in collapsible rectangular cells, that can be transported at about 5 percent of their expanded volume (photo courtesy of ERDC).

Survive

The days of filling sandbags and building trenches and bunkers on the battlefield are long past. Today's warfighter products are faster, lighter, easier to build, and provide much better protection. These factors are the driving force behind new force protection technologies in the ERDC Survivability and Protective Structures research program.

Conventional protective structures create logistical burdens because they are bulky, heavy and labor-intensive to construct. ERDC has developed modular protective structural systems that use geocomposite cells and pultruded fiberglass structural members. These systems are easy to emplace and provide superior stability with predictable ballistic protection.

Geocomposite cells are heavy gauge wire panels, lined with lightweight geotextile fabric, and connected in collapsible rectangular cells that can be transported at about five percent of their expanded volume. Once expanded and filled with soil, gravel or other materials, the cells provide 2- to 4-foot-thick walls for protective revetments, bunkers, observation posts, and fighting positions. The wall's energy-absorbing capacity provides a high degree of ballistic protection against small arms, mortar rounds and artillery fire.

ERDC research has shown that pultruded fibers are viable alternatives to conventional materials, such as wood timbers, for protective design. The fiberglass components reduce shipping weight and labor requirements for construction.

Feedback from the U.S. Army Maneuver Support Center at Fort Leonard Wood, Mo., indicated the need for several standardized protective designs. The ERDC has designed eight protective positions that will be incorporated into all Army Engineer School officer basic programs.

Other materials being tested at ERDC include reactive powder cement based composites that can achieve great compression strength in a matter of days. Thin panels of the material can provide compartmentalized protection in tent facilities or hangars.

ERDC is also researching protection for secondary fragmentation of walls from blasts, which would be useful in military operations in urban terrain (MOUT). Materials, such as spray-applied thermoplastic elastomers or chemically adhered fiber-reinforced plastic sheeting, create a backing for a wall that withstands high blast loads. In addition, Simplified Survivability Assessment software will soon be released in beta version to enhance warfighter capabilities. The software will provide our forces with a single-source guide to evaluate and construct protective positions.

Survivability research includes live-fire tests on standard and new field fortification designs (photo courtesy of ERDC).

Train

As the Army transforms the force, ERDC is providing decision support tools critical to "Fort Future," the Army's focus for addressing future, long-term installation needs. Research will provide an installation modeling and simulation program for planners to use virtual technology to make decisions when posturing Army posts to meet future force structure.

The product to come from Fort Future research efforts will not be a single system, but a "system of systems." The system will integrate existing and emerging data sources and exploit sophisticated information technologies – CAD/GIS, visualization and advanced computer graphics, modeling and simulations, databases, communications, networking, and web programming. Users at multiple working levels will access tiers of information to model planning options and gain insight that supports decisions. Fort Future adds the capability to analyze possible results of decisions five, 10, or even 20 years into the future.

Fort Future systems will be useful at three levels in installation planning: Strategic Planning Tools that identify which installations can accommodate force training, projection, protection, and sustainment; Operational Planning Tools that identify facility requirements (what needs to be built, modified, relocated, etc.); and Installation Tactical Planning Tools that identify available resources, perform constraint scheduling, and help planners decide which requirements are cost/performance effective and determine the consequences if they are not funded.

Operational Support - TeleEngineering

The satellite-based TeleEngineering Communications System, developed at ERDC, enables deployed personnel to send and receive data in a secure or non-secure manner. *(photo courtesy of ERDC)*

Obtaining solutions to engineering problems in contingency operations has, traditionally, been a difficult challenge. With the advent of TeleEngineering – or "reach back" engineering - soldiers and commanders now have easy access to subject matter experts in the United States for help in solving complex engineering challenges.

ERDC developed a satellite-based TeleEngineering Communications System to enable deployed personnel to send and receive data and to conduct video teleconferences in a secure or non-secure manner. TeleEngineering can be conducted over any available communications infrastructure that meets the user's requirements – telephones, facsimile machines, computer networks (email), and video conferencing systems. Many times, however, remote areas lack modern communications infrastructure (phone lines, data lines, ISDN, etc.). In response, ERDC researchers developed a deployable, versatile communications system that can support a wide range of voice and data services globally.

TeleEngineering communications equipment has been deployed around the world in support of contingency operations *(photo by ERDC)*

The Deployable TeleEngineering Communications System is a critical communications component when existing infrastructure is unavailable, damaged, or nonexistent. Compact and highly mobile, the system combines a suitcase-sized satellite terminal with a laptop, camcorder, and roll-around secure videoconferencing unit. It can send and receive computer files, voice communications, video stills, and two-way interactive video conferencing.

TeleEngineering communications kits are integral to the Field Force Engineering initiative that links the Corps of Engineers with forward deployed troops. The kits, now in their third generation of development, are supporting a variety of operations, including U.S. Central Command in Afghanistan. The kits have been fielded with forward engineer support teams, made up of military and civilian personnel from Corps divisions and districts that support the Combatant Commands.

ERDC is now looking at the fourth generation of TeleEngineering communications kits, which will be smaller again than current kits. It has emplaced the infrastructure to support a video bridge at the TeleEngineering Operations Center located at ERDC. This will allow multiple deployed sites to link with other fixed sites over the TeleEngineering Network or other Department of Defense sites. The network currently has 30 fixed sites and 20 deployable kits in support of TeleEngineering operations. TeleEngineering is providing hydraulic analysis of river and watershed systems, imagery requests, transportation and route analysis, and flood analysis in support of warfighter exercises, field force engineering missions, and emergency operations around the world.